

APPROVAL SHEET FOR SUSPENDED LOAD OPERATIONS

SLO-KSC-1995-004

TITLE DOCKING MODULE HANDLING AT THE O&C AND SSPF USING THE NASA PAYLOAD
STRONGBACK OR CUSTOMER SLING

DOCUMENT NUMBER/TITLE OMI L5168, S/MM-02 DOCKING MODULE HANDLING PROCEDURE; OMI
E5006, INSTALL/REMOVE HORIZONTAL PAYLOAD INTO CANISTER

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REQUIRED APPROVAL

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NASA SUSPENDED LOAD OPERATION ANALYSIS/APPROVAL

NUMBER: SLO-KSC-1995-004

OPERATIONS

1. To install or remove the payload keel cover(s).
2. To guide the keel trunnions into the keel latches.
3. Removal of Docking Module from test stand.
4. Grounding of payload in canister.

Note: These operations will be conducted using the customer sling or the NASA payload strongback.

SUPPORTING DOCUMENTS - The associated operational procedure and System Assurance Analyses (SAAs) are as follows:

- OMI L5168, S/MM-02 Docking Module Handling Procedure
- OMI E5006, Install/Remove Horizontal Payload into Canister
- SAA21CRS1-001, 30 Ton Highbay Bridge Cranes - SSPF
- SAA01FS027-002, 27.5 Ton Bridge Cranes - O&C

GENERAL DESCRIPTION

1. Installation or removal of the payload keel trunnion cover(s) requires 1 or 2 persons to be under the suspended payload (depending on the number of keel trunnions). During payload transfer from the test stand to the payload canister and removal of the payload from the canister, 3-16 persons will be partially under (hands only) the suspended NASA payload strongback.

2. Guiding the keel trunnion(s) into the keel latch(es) requires up to 4 persons to be under the suspended payload (depending on the number of keel trunnions).
3. Payload removal from the customer support stand requires 4 persons under the payload sling to remove bolts/supports from the stand and to guide the payload.
4. One person will be permitted to work under the suspended load during contingency payload grounding operations.

These tasks are completed in the following OMI sequences:

- OMI L5168, Docking Module Transfer To Canister Using Customer Sling
- OMI E5006, Payload Transfer From Test Stand and Installation into Canister (O&C/SSPF)

Payload transfer from the test stand involves removal of the payload from the test stand by hoisting the payload sling, positioning the sling over the payload, attaching the sling drop links to the payload trunnions, removing the payload from the test stand, and placing it in the canister. During removal of the payload from the canister, the procedure is reversed.

Installation or removal of the keel trunnion cover(s) requires 1-2 persons under the suspended load, and personnel working at the sill trunnions will be partially exposed (hands only) to the suspended payload strongback. If the load should fall, arms or hands should be pushed out of the way (the payload trunnions are suspended above the retention fittings 6-12 inches).

RATIONALE/ANALYSIS - The suspended load tasks comply with the NASA Alternate Safety Standard as follows:

Alternate Standard Requirement #1a

These operations cannot be conducted without placing personnel under the suspended load. Payload trunnion connections require personnel to work under the customer sling or the NASA payload strongback. Keel trunnion operations require personnel to work beneath the suspended payload.

These trunnion operations at the SSPF and the O&C have been evaluated for alternate methods to complete these tasks, and it has been determined that there are no design, operational, or procedural means to eliminate personnel exposure to a suspended load.

During trunnion operations at the O&C and the SSPF, while the payload is resting in the test stand (holding fixture), the technician has to lean over the rails of the test stand and reach up under the sling to disconnect attach hardware from the stand. This task places the technician beneath the sling, which is suspended overhead, to make the connection or disconnection as required.

During keel trunnion operations, the technician(s) must reach beneath the suspended payload to install or remove the payload keel trunnion cover(s) and to guide the keel trunnion(s) into the keel latch(es). There is no alternate access to the keel trunnion(s) (located underneath the payload), and the cover(s) cannot be installed or removed while the payload is in the test stand or the payload canister. This physical limitation precludes any design, operational, or procedural changes that would eliminate personnel exposure to a suspended load.

Alternate Standard Requirement #1b

The possible use of a secondary support system, to catch the load in the event of a crane failure, was analyzed. It was determined that the use of a secondary support system was not feasible because of positioning of the payload over the test stand, under the payload sling, or in the canister.

Alternate Standard Requirement #1c

1. The maximum number of personnel allowed under the load during installation or removal of the payload keel trunnion cover(s) is 1 or 2 persons (depending on the number of keel trunnions) with 3-16 persons partially exposed to the load (hands only) when using the strongback.
2. The maximum number of personnel permitted under the load while guiding the keel trunnion(s) into the keel latch(es) is up to 4 persons (depending on the number of keel trunnions).
3. The maximum number of personnel permitted under the load during removal of bolts/supports from the Docking Module stand is 4 persons.

Alternate Standard Requirement #1d

1. Installation or removal of the payload keel trunnion cover(s) will be accomplished as quickly and safely as possible to minimize exposure time. It will take 1 or 2 technicians (depending on the number of keel trunnions) up to 60 minutes to install or remove the keel trunnion cover(s).
2. Guiding the keel trunnion(s) into the keel latch(es) will be accomplished as quickly and safely as possible to minimize exposure time. It will take up to 4 persons 15-60 minutes to guide the keel trunnion(s) into the keel latch(es).
3. Removal of bolts/supports from the Docking Module stand will be accomplished as quickly and safely as possible to minimize exposure time. It will take up to 4 persons 60 minutes to accomplish this task.

Alternate Standard Requirement #4

OMI L5168 and OMI E5006 have been revised to permit only the approved number of persons under the suspended payload. The OMI is available on site for inspection during the operation.

Alternate Standard Requirement #6

Suspended load operations associated with hoisting the payload strongback in the O&C involve two 27.5 ton bridge cranes. Payload sling hoisting in the SSPF involves one or two 30 ton bridge cranes depending on which sling is used. The cranes are designed, tested, inspected, maintained, and operated in accordance with the NASA Safety Standard for Lifting Devices and Equipment, NSS/GO-1740.9.

The O&C 27.5 ton and the SSPF 30 ton crane hoists are equipped each with two magnetic holding brakes. All brakes are capable of holding the load up to the respective crane's rated capacity. Each brake's ability to hold the rated load (27.5 tons - O&C cranes, 30 tons - SSPF cranes) is verified annually. The cranes are designed to meet a 5 to 1 safety factor based on ultimate strength for the hoist load bearing components.

When using the customer sling, only one crane is required (a 27.5 ton crane in the O&C or a 30 ton crane in the SSPF). The weight of the customer sling is

5,000 lbs and the payload can weigh as much as 11,000 lbs. The combined load is 16,000 lbs, which is 29.1% of a 27.5 ton crane's capacity and 26.7% of a 30 ton crane's capacity.

The customer sling is rated at 22,000 lbs and is designed for a maximum allowable stress of 131,121 lbs for the structure. The attachment mechanism of the lifting slings is designed to meet a 5 to 1 safety factor based on ultimate strength.

When the NASA payload strongback is utilized for these tasks, two cranes are required simultaneously (dual 27.5 ton cranes in the O&C and dual 30 ton cranes in the OPF). The weight of the NASA strongback is 28,000 lbs and the payload can weigh as much as 11,000 lbs. The combined load is 39,000 lbs, which is 35.5% of the O&C cranes' capacity and 32.5% of the SSPF cranes' capacity.

The lifting slings are rated at 34,000 lbs and are designed to meet a 2.25 to 1 safety factor based on yield strength and a 5 to 1 safety factor based on ultimate strength.

The 27.5 ton cranes in the O&C and the 30 ton cranes in the SSPF are load tested annually at 100% of their rated capacities. Detailed preventive maintenance is performed monthly, quarterly, semiannually, and annually on the cranes to ensure proper operation. A detailed inspection of the lifting slings is performed annually. Nondestructive testing of the slings and crane hooks is performed annually.

Alternate Standard Requirement #7

O&C Cranes

A System Assurance Analysis (SAA) has been completed on the 27.5 ton bridge cranes in the O&C. The SAA includes a Failure Modes and Effects Analysis/Critical Items List (FMEA/CIL) and a hazard analysis (see supporting documents).

The SAA for the 27.5 ton bridge cranes - O&C identifies one single failure point (SFP), the hoist gear reducer, which transmits power and reduces rotational speed from the hoist motor to the rope drum. A sheared key or broken teeth would cause interruption of the load path at the gearbox. This failure would result in the load dropping, which could cause loss of life and/or payload.

There is no history of failure with the SFP in the critical failure mode. A detailed inspection of the gear reducer is performed monthly, and gear reducer oil samples are verified annually. The use of high-quality, reliable components and a comprehensive maintenance, inspection, and test program (including preoperational checks) ensures that the crane systems operate properly.

The associated SAA CIL Sheets for the 27.5 ton bridge cranes - O&C identify all the rationale for accepting the risk of the SFP including design information, failure history, and the operational controls in effect to minimize the risks (maintenance, inspection, test, etc.).

SSPF Cranes

A System Assurance Analysis (SAA) has been completed on the 30 ton bridge cranes in the SSPF. The SAA includes a Failure Modes and Effects Analysis/Critical Items List (FMEA/CIL) and a hazard analysis (see supporting documents). No single failure points were identified.

Alternate Standard Requirement #8 - Visual inspections for cracks or other signs of damage or anomalies are performed on the hoist hooks, hoist beams, hoist cables, hoist rod assemblies, and hoist fittings, and crane functional checks are performed before each operation per NSS/GO-1740.9.

Alternate Standard Requirement #9 - Trained and licensed crane operators shall remain at the hoist controls while personnel are under the load.

Alternate Standard Requirement #10 - Appropriate safety control areas are established before initiating operations. Only the minimum number of people (manloaded in the procedure) will be permitted in this area.

Alternate Standard Requirement #11 - A pretask briefing and a safety walkdown of the area are conducted prior to the lift to ensure that all systems and personnel are ready to support. All participants are instructed on their specific tasks and warned of any hazards involved. Following any crew change, the new personnel are instructed by the task leader on their specific tasks and warned of any hazards involved.


Alternate Standard Requirement #12 - Personnel beneath the suspended load will be in voice contact with the hoist operator and/or task leader. Upon loss of communication, the operation shall stop immediately, personnel shall clear the hazardous area, and the load shall be safed. Operations shall not continue until communications are restored.

Alternate Standard Requirement #13 - Personnel working beneath the load shall be in continuous sight of the hoist operator and/or task leader.

APPROVAL:

DATE:

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